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Potential of Community-Based Forest Management to Mitigate Climate Change in the Philippines

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Abstract Community-based forest management (CBFM) is the principal strategy in managing inhabited 'forest land' in the Philippines. It involves the participation of local communities in various forestry activities to achieve sustainable forestry, advance social justice and improve socioeconomic welfare, and promote a stable and healthy environment. This paper analyses the potential benefits of agroforestry farms in CBFM sites to mitigate climate change. The incorporation of trees in farms and landscapes has led to enhanced carbon storage and sequestration. Half a million hectares of agroforestry farms in CBFM sites in the Philippines are estimated to store 25 MtC while sequestering 2.7 MtC annually. Lessons are drawn from three carbon sequestration projects under development using CBFM as the main approach. Income from carbon credits is not sufficient to recover the cost of tree planting. The transaction costs of forestry CDM projects are substantial and could prove to be the greatest barrier to project fruition. Government institutions must find ways to encourage project developers by simplifying rules and regulations for forestry carbon projects. Forest definition must be assessed. Project developers and the government could also explore the voluntary carbon market which is more flexible than the CDM market. Policy and technical studies must be conducted to ascertain the potential of the REDD for CBFM sites in the country.

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Introduction

Climate change is one of the most challenging issues facing humanity today. The Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report concluded that there is unequivocal evidence that man is affecting the world's climate (Denman et al. 2007). There is considerable interest on the role of terrestrial ecosystems in climate change, more specifically on the global carbon cycle. The world's tropical forests covering 17.6 Mkm^2 contain 428 GtC in vegetation and soils (Watson et al. 2000). It is estimated that about 60 GtC is exchanged between terrestrial ecosystems and the atmosphere every year, with a net terrestrial uptake of about 0.9 ± 0.6 GtC/year for 2000–2005 (Denman et al. 2007). Land use, land-use change and forestry (LULUCF) activities, mainly tropical deforestation, are also major sources of greenhouse gases (GHGs), accounting for 1.6 GtC/year which represents about 20% of anthropogenic emissions.

Forest management activities also have a great potential to mitigate climate change (Nabuurs et al. 2007). Tropical forests have the largest potential to mitigate climate change among the world's forests through conservation of existing carbon pools (e.g. reduced impact logging), expansion of carbon sinks (e.g. reforestation, agroforestry) and substitution of wood products for fossil fuels. Converting grassland, agricultural fallow and permanent shrubland to tree-based systems promotes considerable increase in carbon storage (Roshetko et al. 2007). For example, it is estimated that converting unproductive grasslands and croplands globally to agroforestry can sequester 586 MtC/year by 2040 or 29% of the 2008 emissions of the USA (IPCC 2000). In addition to their role in mitigation, agroforestry systems can help smallholders adapt to climate change (Verchot et al. 2007).

From one of the world's biggest exporters of tropical hardwoods in the 1960s, the Philippines is now a net importer of wood. Philippine forest resources degenerated because of massive logging, extreme poverty and shifting cultivation. At the end of the 19th century, 70% of the country's total land area (21 Mha) was covered with lush forest (Garrity et al. 1993). At present, only about 20% (7 Mha) of forests remain, less than 1 Mha of which are old-growth forests. There are perhaps 8 Mha of degraded or non-forested 'forest' land. The current deforestation rate has been estimated at 100,000 ha/year (Lasco et al. 2001a). The socioeconomic and ecological consequences of forestland degradation include widespread poverty, accelerated soil erosion, and massive flooding of low-lying areas.

In the last two decades, CBFM has become an important lynchpin of the Philippine government's program to address upland poverty and forest land rehabilitation. CBFM has been declared as the national strategy for forest land management. There is increasing interest in forestry projects to help mitigate climate change in the Philippines. Recent studies have shown the great potential of agroforestry systems to sequester carbon (Lasco et al. 2007a, b; Racelis et al. 2008).

The objective of this paper is to assess the potential climate change mitigation benefits of CBFM activities in the Philippines. This analysis uses new data from the Forest Management Bureau (FMB) of the Department of Environment and Natural Resources (DENR) as well as recent information on the potential of agroforestry systems in the Philippines to sequester carbon. The paper examines whether CBFM participants could potentially benefit from the emerging carbon market under the UN Framework Convention on Climate Change (UNFCCC). With the Copenhagen Accord recognizing the importance of reducing emissions from forests and enhancing forest sinks (i.e. REDD+) (UNFCCC 2009), the carbon market is expected to further grow.

Overview of CBFM in the Philippines

To date, close to 6 Mha of forest land are under some form of community forest management. Of these, about 4.7 Mha have been issued with various forms of land tenure instruments including about 1.62 Mha issued with Community Based Forest Management Agreements or CBFMAs (FMB 2004). A CBFMA is an agreement between the government and the local community, represented by the people's organization as forest managers, which has a term of 25 years and is renewable for another 25 years. It allows organized communities to harvest timber from plantations and second growth forest subject to existing regulations on timber harvesting, on the condition that the area will be protected and managed according to the principles of sustained-yield forest management. The community must also use a portion of the income derived from harvesting to protect, renew and improve the forest resources and to engage in alternative sources of livelihood.

It is estimated that about 690,000 households were involved in the CBFM program as of 2004 (FMB 2004). At an average size of about six persons per household in the Philippine uplands, this means that there were about 4.14 M people potentially benefiting directly from the program.

In response to the problem of shifting cultivation in the uplands, the national government is promoting agroforestry as the main alternative production system in CBFM sites. Agroforestry refers to 'a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the landscape, diversifies and sustains production for increased social, economic and ecological benefits' (Leakey 1996). In short, agroforestry is simply 'trees on farms.' In general, trees have dual roles in an agroforestry system: protective and productive. It has long been observed that the tropical rainforest is the best cover for tropical soils, especially in sloping areas. Although agroforestry systems cannot duplicate the forest in terms of its ability to protect the environment, the introduction of trees will nevertheless greatly enhance the protective ability of upland farms.

Although the basic function of trees in an agroforestry system is the ability to protect the site, they also provide economically valuable products. These products include wood (firewood, timber, pulpwood), fruit, fodder, resins, latexes, medicinal

parts, and food. These products are important especially from the perspective of upland farmers.

Latest data from the FMB reveal that there are more than 500,000 ha of agroforestry farms that have been developed under the CBFM (Table 1). This represents a significant improvement in land cover in the Philippine uplands in the last two decades. Reforestation efforts primarily state-led and tree plantation establishment has had mixed results in the last 40 years. Official data shows that about 1.5 million ha were reforested from 1973 to 2008 (FMB 2009). However, total tree plantation area was only about 280,000 ha in 2003 suggesting a very low survival rate. Of the total agroforestry area under CBFM, Region 11 in Mindanao had the biggest share. This is expected considering the large area of suitable lands in the region. All regions in the country are represented representing government's tendency to allocate budget equitably. The differences in area could be attributed to differing area suitable for agroforestry farm development.

Table 1 Total area of agroforestry farms developed under CBFM

Region	Agroforestry development in CBFM areas as reflected in CBFM information system[a]	GPOA[b]	CARP support[c] 2007–2009 sites	Total
Luzon	262,165	6,578	904	268,742
CAR	43,438	2,333	99	45,771
1	41,276	299	21	41,574
2	79,417	534	248	79,951
3	12,041	2,093	240	14,134
4a	9,686	247	160	9,933
4b	46,676	308	56	46,984
5	29,630	764	80	30,395
Visayas	35,334	1,918	1,217	37,252
6	10,318	555	425	10,872
7	14,550	609	282	15,159
8	10,466	754	510	11,220
Mindanao	215,754	4,616	1,301	220,370
9	19,902	356	291	20,258
10	23,628	729	389	24,357
11	120,790	362	274	121,152
12	8,892	511	225	9,403
13	34,118	2,658	122	36,776
ARMM	8,424			8,424
Philippines	513,253	13,111	3,422	529,786

GPOA general program of action; *CARP* comprehensive agrarian reform program

[a] Up to 2004

[b] 2005 to November 2008

[c] As of May 2009

Agroforestry Systems in the Philippines

The main reason for the Philippine government's emphasis on agroforestry is to help farmers meet their food and cash needs while conserving biophysical resources. This is because CBFM projects are in sloping areas in the uplands which are prone to soil erosion. There are numerous types of agroforestry systems currently in use in the Philippines (Mercado et al. 2001; The Philippines Recommends for Agroforestry Technical Committee 2006). Alley cropping systems have been promoted in government programs since the 1980s. These involve planting of woody perennials along contour lines and growing agricultural crops in 'alleys' formed between two hedgerows. The one metre wide hedgerows are composed of one or two rows of woody perennials and are regularly pruned to prevent shading. The basic idea behind planting hedgerows is to minimize soil erosion by trapping sediments at the base of the hedgerows and reducing surface runoff velocity. After a few years terraces are formed. In addition, if pruning's are used as green manure, soil nutrients are replenished, thereby promoting more rapid nutrient cycling.

Another common agroforestry practice is multistorey systems which are characterized by at least two vertical layers of canopy. These mimic the structure of a tropical rainforest with its attendant advantages. The upper canopy is composed of light-demanding species while the understorey is made up of shade-tolerant species. Examples include coconut-based multistory systems, rubber-based agroforestry, and planting of coffee trees under various tree species including *Samanea saman* and *Pinus kesiya*. Multistorey systems are perhaps the most widespread type of agroforestry in the country.

Planting trees around the farm or homelot is another common practice in rural areas, providing protection, privacy and valuable products to farmers. Leguminous species including *Gliricidia sepium*, *Leucaena leucocephala*, *Sesbania grandiflora* and *Moringa oleifera* are commonly used. Other types of agroforestry scattered all throughout the Philippine islands include improved fallow systems, windbreaks and taungya.

Potential Climate Change Mitigation of CBFM Areas

In the last 10 years, data have become available on the carbon stocks and sequestration rates of agroforestry systems in the Philippines. It was estimated that the mean annual rate of carbon sequestration of *Leucaena leucocephala* trees in the Naalad improved fallow system using biomass data generated by Kung'u (1993) is 5.3 tC/ha for the 6 year fallow rotation (Table 2). Just like traditional fallow systems, the Naalad system has two basic components, the fallow field and the cultivated field. In traditional shifting cultivation, the natural fallow period is typically longer than the cropping period (MacDicken 1990). In the Naalad system, farmers discovered more than 100 years ago that by introducing *L. leucocephala* they could shorten the fallow period to about 6 years. At the end of the fallow period, trees are cut and the field is planted with maize. Stems of trees are used to construct soil conservation structures which decay over time thus releasing carbon

Table 2 Above-ground carbon stocks of a *Leucaena leucocephala* fallow in Naalad, Cebu island, Philippines (Source: Lasco and Suson (1999)

Years under fallow	Above-ground biomass (Mg/ha)	Carbon density (Mg/ha)	Carbon accumulation (Mg/ha/year)
1	4.3 d	2.2	2.2
2	16.1 cd	8.1	5.9
3	17.6 cd	8.8	0.7
4	36.4 bc	18.2	9.4
5	53.8 ab	26.9	8.7
6	63.6 a	31.8	4.9
Mean	32	16	5.3

back to the atmosphere. This is the main limitation of fallow systems for climate change mitigation. The carbon storage in trees is temporary because they are cut and sometimes burned at the end of fallow.

The total carbon stocks of a multistory and an alley cropping system in Mt. Makiling, Laguna province, was also studied (Lasco et al. 2001b). Alley cropping was found to have little carbon stored in the biomass (1.69 tC/ha) because *Gliricidia sepium* trees are planted only as hedgerows and are regularly pruned. From this, it can be inferred that alley cropping has a low potential for carbon sequestration if it is regularly pruned. In contrast, the same study showed that the multistory system had a carbon storage in above-ground biomass of 116 tC/ha), indicating a greater potential to sequester carbon, perhaps at par with smallholder tree farms. In another study, a coconut-based multistorey system in Mt. Makiling had carbon stocks of 39 tC/ha in above-ground biomass (Zamora 1999). Because of the great diversity of multistory systems in the country, it is expected there will be a wide range of carbon storage reflective of the above-ground biomass. In terms of rate of carbon sequestration, a mixed multistorey system in northern Philippines was reported to sequester an annual average of 5.1 tC/ha (Castro 2000).

The limited data reveal high variation in the carbon storage of agroforestry systems (Table 3), depending largely on how dominant the tree component of the

Table 3 Summary of carbon stocks and carbon sequestration rate of agroforestry systems in the Philippines

AF system	Carbon stock (tC/ha)	Carbon sequestration rate (tC/ha/year)	Reference
Naalad	31.8	5.3	Lasco and Suson 1999
Alley cropping	1.7	–	Lasco et al. 2001b
Coconut	39.0	–	Zamora 1999
Multistory system	116.0	5.1	Lasco et al. 2001b, Castro 2000
Mean	47.1	5.2	
Standard deviation	48.7	0.1	

system is. Alley cropping has been the most commonly promoted agroforestry system in the Philippines especially in the 1990s. This is because of its many ecological and economic benefits including soil conservation and increased yield of agricultural crops (Palmer 1996; Young 1997). There are many possible reasons for the low carbon stocks in alley cropping. First, only about 20% of the area is occupied by woody perennials in a typical alley cropping system with 5 m hedgerow interval. The alleys are usually planted to annual crops such as rice and corn which do not store carbon in the long term. Second, the hedges are pruned regularly, suppressing the growth of biomass. There are ways, however, by which carbon sequestration can be enhanced in alley cropping systems. Woody perennials including fruit trees can be integrated in the alleys to increase long-term carbon storage. For example, for every two alleys of annuals, there could be one alley of perennials. Such a strategy can substantially increase carbon storage because trees in alleys reach full growth. In addition, because the soil is a larger carbon pool in an alley cropping system, soil conservation activities can minimize loss of organic matter due to erosion.

Using the mean carbon storage and rate of sequestration in Table 2, the total carbon storage and sequestration potential of CBFM sites in each region in the Philippines was estimated (Figs. 1, 2). Reflecting the area coverage, the top three regions in terms of climate change mitigation are Regions XI, II and IVb. Overall, CBFM sites in the Philippines store 24.7 MtC and sequester 2.7 MtC per year.

Converting the total amount of carbon stored in the CBFM sites into its equivalent CO_2 value, there are an equivalent of about 90 Mt of CO_2 accumulated in CBFM areas. These represent around 90% of the Philippines' total emissions in 1994, which is reported to amount to 100 Mt CO_2 (Philippines' Initial National Communication 1999). In terms of the rate of sequestration, the CBFM areas are able to capture 9.91 $MtCO_2$-eq from the atmosphere which is about 10% of the 1994

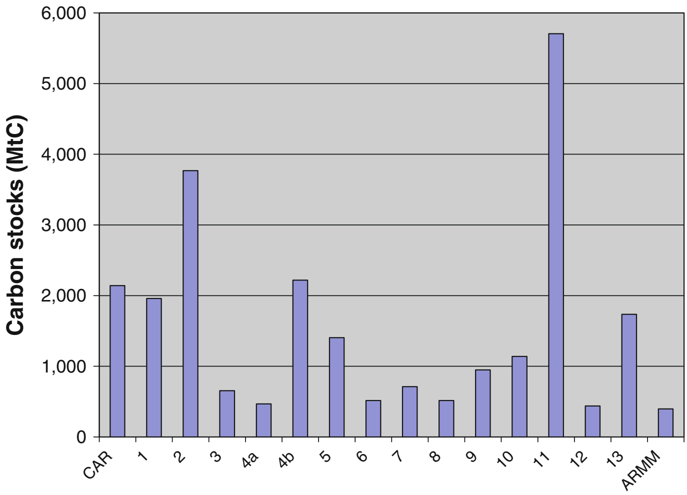

Fig. 1 Total carbon stocks of CBFM sites in various regions in the Philippines (in M tons C)

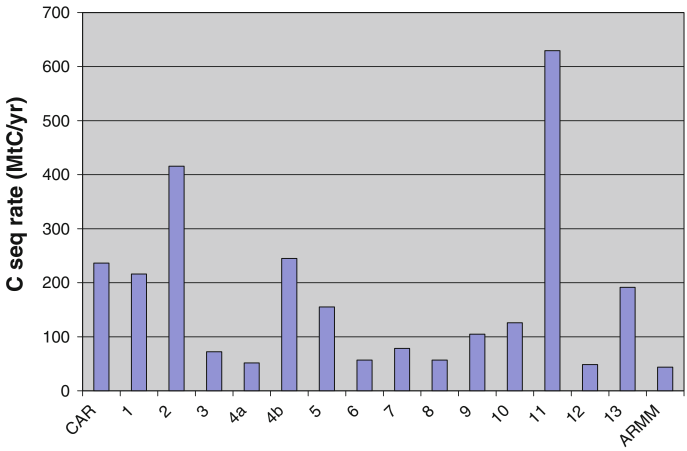

Fig. 2 Total carbon sequestration rate of CBFM sites in various regions in the Philippines (in tons C/year)

emissions of the country. That is, CBFM areas play a key role in mitigating climate change in the Philippines because they absorbs substantial amount of carbon being emitted by wastes, agriculture, energy and industry.

Agroforestry Carbon Projects Under Development

In the last 5 years, there has been a rising interest in climate change mitigation projects in the Philippines. Much of this interest is probably due to the recent publicity associated with climate change in general and CDM in particular. At least three CDM forestry projects are under development, all using some form of agroforestry within a CBFM framework. The first of these is the LLDA-Tanay Streambank Rehabilitation Project. The main proponents or sellers of this project are the Municipality of Tanay and the Laguna Lake Development Authority (LLDA). The implementers will be farmers in the Tanay watershed. The main objective of the project is to reduce greenhouse gases (i.e. CO_2) in the atmosphere while helping rehabilitate the Tanay watershed and providing socioeconomic benefits to the local people. The design and implementation of this project is being supported by the World Bank (WB). The WB provides technical assistance and funding for data gathering, packaging of the project for CDM, and in selling the carbon credits to be generated by the project.

The LLDA is the prime mover of the project with assistance from the WB. An indigenous people's (IP) organisation, which had committed portions of their LGU-donated land, is the implementer. It is expected that the IP community will plant and maintain the trees for carbon sequestration. The Tanay LGU will provide technical inputs including choosing appropriate species, nursery propagation, and planting techniques. The project involves the establishment and management of a 52 ha forest consisting of pure forest plantations and agroforestry areas in Barangay

Cuyambay, Tanay, Rizal. Native species to be planted include narra (*Pterocarpus indicus*), dao (*Dracontomelon dao*), ipil (*Instia bijuga*), molave (*Vitex parviflora*), cashew (*Anacardium occidentale* L) and kakauate (*Gliricidia sepium* (Jacq.) steud). The carbon credits from the project will be purchased by the WB's Biocarbon Fund. The LLDA has signed an emission reduction purchase agreement with the Bank to this effect. Over the 20-year project period, the project will have an estimated total net carbon benefits of 20,800 tCO2-eq (PDD 2007), with a value of about USD 140,000 at USD 5 per tCO2-eq.

The second is the Conservation International (CI)-Philippines Sierra Madre Project. The CI-Philippines has made concerted efforts to build alliances with local communities, the private sector, government agencies and NGOs to facilitate the management of the Sierra Madre Biodiversity Corridor and strengthen enforcement of environmental laws. It uses a multifaceted approach to alleviate threats and to restore and protect 12,500 ha of land within the corridor. The main strategy of the project will be community-based forest management (CBFM). The key stakeholders of the project will be the local community and PO, local NGOs, the LGU, the DENR, the project monitoring team, and the funding organization. After 30 years, it is expected that a total of 5.1 MtC will be sequestered by the project most of which will come from the reforestation component (4.5 MtC).

The third is the Kalahan Forestry Carbon Project. The Ikalahan Ancestral Domain covering 58,000 ha of mountainous forest and farmlands is located in the provinces of Nueva Ecija and Nueva Vizcaya in northern Luzon. For the Kyoto market, Kalahan Educational Foundation (KEF) aims to convert the 900 ha of marginal and abandoned agricultural land into a more productive tree-based system. In addition, the project aims to protect the watershed, enhance biodiversity, and improve the land beauty of the area.

The main strategy of the project will be CBFM. Key stakeholders of the project include the Ikalahan-Kalanguya indigenous communities, local NGOs, the DENR, the project monitoring team, and the World Agroforestry Centre. All the project activities will be developed with the participation of indigenous communities in the project area. KEF will catalyze the community organizing and development process and manage and implement the project. The project monitoring team will quantify the carbon sequestered and assess the impacts of the project. The funding organization will provide the financial resources for the project. It is estimated that the 900 ha area will be able to sequester 89,776 tCO_2-eq for 20 years under the medium tree growth scenario.

The initial experiences of these projects provide some important lessons:

1. The income from carbon credits is not sufficient to recover the cost of tree planting. Using standard DENR costs, planting and maintenance costs amount to about USD 1,000 in the first 3 years. In contrast, income from carbon credits is estimated to be about USD 250/ha for 10 years (at 5 tC/ha/year and USD 5/tC). This implies that carbon credits are best used as a supplementary source of income for farmers and project developers.
2. The transaction costs of forestry CDM projects are enormous and can be as high as USD 200,000 (Neef and Henders 2007). This could prove to be the greatest

barrier to project fruition. One way to overcome this barrier is to partner with a potential buyer who may be able to shoulder the upfront costs as in the case of LLDA and the World Bank cited above. CI's project also has support coming from abroad. In contrast, the Kalahan project is basically relying on its own resources. Some technical and financial assistance is provided by the World Agroforestry Centre (ICRAF) but at a much lower level than the other two projects.

3. Government institutions and particularly the DENR-FMB must find ways to encourage project developers by simplifying national rules and regulations for forestry carbon projects. Currently, forestry projects have few takers because of their high complexity and transaction costs. Adding more hurdles will further discourage potential project developers.
4. At the time of writing, the Philippines has not submitted its official forest definition to the United Nations Framework Convention for Climate Change (UNFCCC) CDM Executive Board which is a pre-requisite for project approval. The selected definition and especially the minimum crown cover (which can range from 10 to 30%) is highly critical in determining if a project will qualify. At present, the official definition of the DENR is a 10% minimum crown cover which can effectively rule out most agroforestry projects. In contrast, a 30% cover will allow the inclusion of most agroforestry projects. The DENR is aware of this issue and is awaiting the results of national forest mapping before making a final decision.
5. Project developers and the government must also explore the voluntary carbon market which is more flexible than the CDM market.
6. Policy and technical studies must be conducted to ascertain the potential of the UN-REDD (United Nations-Reducing Emissions from Deforestation and Forest Degradation) Programme for CBFM sites in the country.

Potential Benefits to CBFM of REDD

Several sectors have recently advocated payments for avoiding deforestation in developing countries under the so-called 'Reducing emissions from deforestation and forest degradation' or REDD, in a post-2012 agreement. This is timely considering that tropical deforestation accounts for 20% of all greenhouse gas emissions (Denman et al. 2007). The Copenhagen Accord recognizes this and seems to favour a REDD+ option (UNFCCC 2009). However, 'the design and implementation of REDD policies will be neither simple nor straightforward, given the complexity of the social, economic, environmental and political dimensions of deforestation. Many of the underlying causes of deforestation are generated outside the forestry sector, and alternative land uses tend to be more profitable than conserving forests' (Kanninen et al. 2007).

In the Philippines research on REDD is just commencing. Various Philippine forest types contain large carbon stocks which could be released to the atmosphere. Indeed, since the 1500s, deforestation of 20.9 M ha of Philippine forests contributed

Table 4 Forest cover change in the Philippines

Year	Forest area (Million ha)
1500	27
1900	21
1934	17
1969	10.6
1987	6.4
2004	7.2

Data from FMB (Forest Management Bureau) (2004) and Garrity et al. (1993)

3.7 G tC (or billion tons C) to the atmosphere of which 2.6 Gt were released this century (Lasco and Pulhin 2001). However, recent data from the DENR show that the rate of deforestation has tapered off and that forest cover is on the rise (Table 4). If this is the case, then the country cannot expect payments for reducing deforestation because the baseline will show that deforestation is already on the decline even without carbon payments.

A case may be made that while total forest area is increasing, forest degradation is taking place. Cutting of trees inside the forest by various forms of logging could lead to lower biomass and carbon stocks. For example, in Mindanao logging led to a decline of aboveground C stocks by about 50% or 100 MgC/ha (Lasco et al. 2006). There are no data available on the extent of biomass degradation in Philippine forests.

CBFM sites contain forested areas or are near forested land, hence local community members in CBFM sites could have a vital role to play in forest conservation. Depending on how a REDD mechanism is configured, they could potentially reap benefits from carbon payments by helping reduce forest loss (Table 5). If only avoided deforestation is included then there will be no benefits for CBFM farmers because the Philippines will not qualify, assuming a historical baseline is used. If avoided forest degradation is included, the CBFM farmers could potentially benefit because they have an important role to play in reducing biomass lost from forests. Some of them gather wood from forests for their own use such as for timber and fuelwood. They can also serve as guardians of the forest to prevent outsiders from illegally cutting trees and thereby help reduce carbon loss. If a REDD+ option is agreed upon, CBFM farmers will even have a higher potential to earn carbon payments. This could also potentially mean that the afforestation and reforestation components of the CDM can be combined with REDD+, maximizing carbon payments for smallholders. After the latest round of negotiations in December 2009, the REDD+ option is specifically recognized in the Copenhagen Accord (UNFCCC 2009).

There are a number of issues that need to be resolved if CBFM sites are to benefit from carbon payments through REDD. These include, among others, setting baselines and additionality, leakage, and equitable sharing of carbon payments.

As of now, there are no UNFCCC rules on how baselines are to be determined under REDD, although there are some options have been proposed (GOFC-GOLD

Table 5 Potential benefits of CBFM smallholders under various REDD options under discussion in the UN framework convention on climate change

REDD options under discussion	Types of activities included	Land included	Role and benefits of CBFM smallholders	Policies and institutions (governance)
RED	None—Philippines forest area increasing recently so credit for RED unlikely	Possibly none	None because no land will qualify	DENR will be the lead unit involved relevant policies: logging banned in all primary forests (1 M ha; logging allowed in second-growth forests (3 M ha); protected areas law (NIPAS); law for indigenous peoples lands (IPRA)
REDD	In the Philippines, there is anecdotal evidence (e.g. illegal cutting) that forest degradation is going on	7 M ha	CBFM smallholders potential beneficiaries as 'guardians' of the forest. They can help protect forests from loss of biomass through logging and fuelwood gathering. They can also assist local authorities in preventing encroachment of migrants in natural forests. In this role, smallholders could have a share of carbon payments	DENR will be the lead unit involved policies same as above
REDD+	Reducing the rate of biomass degradation in forests enrichment planting ANR reforestation/agroforestry	7 M ha of forest 9 M ha of open land in 'forest' land	Same as above. In addition, CBFM smallholders can implement projects that enhance carbon stocks such as sustainable forest management, agroforestry, reforestation, and ANR in open lands under their management. These will increase carbon payments for smallholders	DENR will be the lead unit involved DA could also be involved policies same as above
REDD++/ REALU	All the above plus agriculture (e.g. rice cultivation, fish ponds)	All forest land plus total agricultural land; potentially the whole 30 M ha	Same as above. In addition, agricultural practices that reduce greenhouse gas emissions can generate payments to smallholders	DENR, DA, DAR policies above plus AFMA (Agricultural Modernization Act), agrarian reform law (CARP Act)

RED reducing emissions from deforestation; *REDD* reducing emissions from deforestation and forest degradation

2009; Terra Global Capital LLC 2009). Based on the experience in CDM, the most feasible in terms of availability of data and cost-effectiveness seems to be based on historical rates of deforestation and reforestation in CBFM sites. For example, CBFM has been going on for 20 years and total area developed for agroforestry is about 500,000 ha for an average rate of about 25,000 ha per year. There are no data on forest loss nor on biomass degradation in CBFM areas in the Philippines. Historical rates can be estimated using remote sensing data and GIS analysis. Baselines can be estimated at the national scale and at the project scale with the former setting the boundary for the latter. Once baselines are set, then additionality of proposed activities can be estimated. For example, in agroforestry development, a case can be made that planting more than 25,000 ha per year would be additional to the baseline case.

Another concern is that of leakage which is the decrease or increase in greenhouse gas benefits outside the project's accounting boundary as a result of project activities (Watson et al. 2000; Brown et al. 2000). It is possible that increasing forest protection and tree planting in CBFM areas could lead to increased deforestation in adjacent areas. Thus, it is essential to include leakage monitoring in any carbon project. There are no studies on assessing the leakage effect of CBFM projects in the country. A study in the northern Philippines reveals that increasing adoption of improved land management technologies such as agroforestry could be a way to reduce leakage (Lasco et al. 2007b) In this regard, sustainable management of forests is also key to ensuring that goods and services continue to flow from the forests.

Another important issue is how to share carbon payments if they do come. There are many stakeholders of forests in the Philippines. At the local level, CBFM communities are the land managers. On the government side, local government units as well as line agencies have a role to play in implementing forest projects. In many cases, NGOs provide technical assistance to upland dwellers. Many upland communities also belong to indigenous people's groups.

Conclusions

The Philippines has great potential for climate change mitigation in CBFM sites around the country. There are still many open areas that could be further developed by the introduction of trees, thereby increasing carbon sequestration. The emerging carbon market such as the CDM could be tapped to capture carbon benefits for small upland farmers. If a REDD+ option is approved, there is a higher potential for carbon payments for smallholders.

Small farmers are the de facto managers of natural resources in the uplands. These areas provide numerous environmental services one of which is carbon storage and sequestration. The CBFM program in the Philippines should explore whether small farmers can benefit from the carbon market through their role in climate change mitigation.

The research community has a responsibility to ensure that relevant information is available to project developers. Among the knowledge gaps that need to be filled

are carbon sequestration rates of Philippine trees, especially in various agro-ecological zones of the country, and economic analysis of agroforestry carbon projects. There is a need for development of models of agroforestry systems that can be used to aid in optimizing carbon sequestration and economic benefits.

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